SECTION 23 09 23

DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

Design Intent: The hospital has developed an open protocol Building Automation System based on the Tridium AX system. All modifications and additions to the BAS at the hospital are to be an extension of this system.

Responsibilities: The Temperature Control Contractor shall be responsible for fully coordinating and providing all necessary devices for interconnection between existing equipment controls and new equipment. This includes providing all necessary switches, resistors, transformers, etc… such as P/E switches, E/P switches, etc… This coordination shall occur prior to beginning any work. The Temperature Control Contractor is responsible for all new installation work as well as integrating the new equipment into the existing Tridium AX system. All software work involving this integration process is the responsibility of the Temperature Control Contractor and MUST be completed by a Tridium Certified Technician. The TCC must submit a copy of the certification documentation for the system programmer prior to completing any work in order to insure the integrity of the hospital's BAS. The TCC is also responsible for providing and installing all routers, switches, JACE's, software licenses, drivers, etc. as needed for a complete installation including full integration. The TCC is responsible for all Graphics generation and point mapping of points to be added in the project. The TCC shall utilize the existing database as an example for all programming, graphics, animations, and point mapping for work done on the project in order to maintain consistency within the BAS.

JACE Licensing: All JACE's installed at the hospital shall be provided with an OPEN license, insuring that they can be accessed with the existing Tridium WEBS software suite, as well as insuring that any Tridium Certified Technician can work on the system.

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management system (FMCS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

B. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

C. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.2 SYSTEM DESCRIPTION

A. The entire Temperature Control System (TCS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via LonMark™/LonTalk™ and/or BACnet™ communication protocols to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturers. Equivalent LonWorks™ or BACnet™ products must be approved in writing by the COR and be submitted for approval ten (10) days prior to the date of the bid submittal.

B. The Temperature Control Systems (TCS) consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.

C. The Facility Management and Control System (FMCS) shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonMark™/LonTalk™ (IDC) and/or BACnet™ (IBC) controllers and other open protocol systems/devices provided under Division 23 or Division 26.

D. The Facility Management and Control System (FMCS) as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara AX Framework™. Equivalent products must be approved in writing by the consulting Engineer and be submitted for approval ten

(10) days prior to the date of the bid submittal. Systems not developed on the Niagara AX Framework™ platform are unacceptable.

E. The Facility Management and Control System (FMCS) shall monitor and control equipment as called for by the "Sequence of Operation" and points list.

F. The Facility Management and Control System (FMCS) shall provide full graphic software capable of complete system operation for up to 34 simultaneous Thin-Client workstations.

G. The Facility Management and Control System (FMCS) shall provide full graphic operator interface to include the following graphics as a minimum:

1. Home page to include a minimum of six critical points, i.e. Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW etc.

2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.

3. Detail graphics for each mechanical system to include; AHU's (Air Handling Units), Reheat Coils, Motorized Dampers, and Exhaust Fans as a minimum.

4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.

H. The Facility Management and Control System (FMCS) shall provide the following data links to electronically formatted information for operator access and use.

1. Project control as-built documentation; to include all TCS drawings and diagrams converted to Adobe Acrobat .pdf filers.

2. TCS Bill of Material for each system.

3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.

4. Sequence of operation for all TCS provided systems.

I. The FMCS shall provide automated alarming software capable of sending messages to email compatible cellular telephones and pagers via the owner's e-mail service. The email alarm paging system shall be able to segregate users, time schedules, and equipment, and be capable of being programmed by the owner.

J. Any dedicated configuration tool required for controller configuration shall have the capability to be launched from within the applicable

Network Management Software. If the configuration tool(s) can not be launched from the Network Management Software, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.

K. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted. Contractor shall convey all software tools and their legal licenses at project close out.

1.3 SUBMITTAL

A. Eight copies of shop drawings of the components and devices for the control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. Division 26 contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to the Division 23 contractor for proper coordination of work.

1. Damper Schedule: Damper and actuator sizing shall be performed, and a schedule created by the manufacturer. The schedule shall include a separate line for each damper and a column for each of the damper attributes: Damper Identification Tag, Location, Damper Type, Damper Size, Duct Size, Arrangement, Blade Type, Velocity, Pressure Drop, Fail Position, Actuator Identification Tag, Actuator Type, and Mounting.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and protocol. Though the Division 23 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire

Wide Area Network (WAN) and/or Local Area Network (LAN) utilized by the FMCS.

1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.

C. Submittal shall also include a complete point list of all points to be connected to the TCS and FMCS. Division 23 and 26 contractors shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the FMCS.

D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner.

E. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work. The Division 23 contractor shall be responsible for as-builts pertaining to overall TCS and FMCS architecture and network diagrams. All as-built drawings shall also be installed into the FMCS server in a dedicated directory.

1.4 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

> DDC   Direct Digital Controls
>
> FMCS Facility Management and Control System
>
> GUI   Graphical User Interface
>
> IBC   Interoperable BACnet Controller
>
> IDC   Interoperable Digital Controller
>
> LAN   Local Area Network

NAC   Network Area Controller

OOT   Object Oriented Technology

PICS   Product Interoperability Compliance Statement

PMI   Power Measurement Interface

POT   Portable Operator's Terminal

TCS   Temperature Control System

WAN   Wide Area Network

WBI   Web Browser Interface

1.5 DIVISION OF WORK

A. The Division 23 contractors shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

B. The Division 23 contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or wide area network.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. Division 26, Electrical:

1. Providing motor starters and disconnect switches (unless otherwise noted).

2. Power wiring and conduit (unless otherwise noted).

3. Provision, installation and wiring of smoke detectors (unless otherwise noted).

4. Other equipment and wiring as specified in Division 26.

1.7 AGENCY AND CODE APPROVALS

A. All products of the TCS and FMCS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems

2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "signal Equipment"

3. CE

4. FCC, Part 15, Subpart J, Class A Computing Devices

1.8 SOFTWARE LICENSE AGREEMENT

A. The Owner shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.

C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara AX Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and all connected routers and devices.

1.9 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.10 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit

runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 MATERIALS
2.1 GENERAL

A. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.

2.2 ACCEPTABLE MANUFACTURERS

A. Basis-of-Design: Honeywell WEBs-AX™ as installed by Taycon Building Technologies, Inc. Subject to compliance with requirements, provide either the product named or an alternate product by one of the other manufacturers specified.

1. Automated Logic

2. Delta Controls

3. Honeywell as Installed by Taycon Building Technologies, Inc.

4. Johnson Controls

5. Siemens Building Technologies

6. Vykon

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™, LonWorks™ technology, MODBUS ™, OPC, and other open and proprietary communication protocols into one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file and a resource file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write

functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.

C. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for local network connected user interfaces.

   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

A. The Local Area Network (LAN) shall be a 100 Megabit/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements:

   1. Ethernet; IEEE standard 802.3

   2. Cable; 100 Base-T, UTP-8 wire, category 5

   3. Minimum throughput; 100 Mbps.

2.5 NETWORK ACCESS

A. Remote Access.

   1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server

providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.6 NETWORK AREA CONTROLLER (NAC)

A. The Division 23 contractor shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Divisions 23 and 26. It is the responsibility of the Division 23 contractor to coordinate with the Division 26 contractors to determine the quantity and type of devices.

B. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of LonWorks controller data and BACnet controller data
7. Network Management functions for all LonWorks and/or BACnet based devices

C. The Network Area Controller shall provide the following hardware features as a minimum:

1. One Ethernet Port – 10/100 Mbps
2. One RS-232 port
3. One LonWorks Interface Port – 78KB FTT-10A if Lon controllers are used and/or One RS-485 port if BACnet controllers are used.
4. Battery Backup
5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
6. The NAC must be capable of operation over a temperature range of 32 to 122°F
7. The NAC must be capable of withstanding storage temperatures of between 0 and 158°F
8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

D. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

F. Event Alarm Notification and actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network, or remote via dial-up telephone connection or wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
   a. In alarm
   b. Return to normal
   c. Fault condition

4. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and/or classes of alarms, i.e.: security, HVAC, Fire, etc.

5. Provide timed (schedule) routing of alarms by class, object, group, or node.

6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Controller and network failures shall be treated as alarms and annunciated.

H. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text

2. Email of the complete alarm message to multiple recipients via the owner's e-mail service. Provide the ability to route and email alarms based on:
   a. Day of week
   b. Time of day
   c. Recipient

      3. Pagers via paging services that initiate a page on receipt of email message via the owner's e-mail service

      4. Graphic with flashing alarm object(s)

      5. Printed message, routed directly to a dedicated alarm printer

I. The following shall be recorded by the NAC for each alarm (at a minimum):

      1. Time and date

      2. Location (building, floor, zone, office number, etc.)

      3. Equipment (fan #, access way, etc.)

      4. Acknowledge time, date, and user who issued acknowledgement.

      5. Number of occurrences since last acknowledgement.

J. Alarm actions may be initiated by user defined programmable objects created for that purpose.

K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

L. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

M. Provide a "query" feature to allow review of specific alarms by user defined parameters.

N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.7 Data Collection and Storage

A. The NAC shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:

      1. Designating the log as interval or deviation.

      2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

      3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

      4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.

      5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:

      1. HTML

      2. XML

      3. Plain Text

      4. Comma or tab separated values

      5. PDF

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

      1. Archive on time of day

      2. Archive on user-defined number of data stores in the log (buffer size)

      3. Archive when log has reached it's user-defined capacity of data stores

      4. Provide ability to clear logs once archived

2.8 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the NAC), to another NAC on the network, or to a server. For each log entry, provide the following data:

      1. Time and date

      2. User ID

3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.9 DATABASE BACKUP AND STORAGE

A. The NAC shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 ADVANCED UNITARY CONTROLLER

A. The controller platform shall be designed specifically to control HVAC – exhaust fans. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation" as outlined in Section 4.

B. Minimum Requirements:

1. The controller shall be capable of either integrating with other devices or stand-alone operation.

2. The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for LonWorks™ network communications.

   a. FLASH Memory Capacity: 116 Kilobytes with 8 Kilobytes for application program.

   b. FLASH Memory settings retained for ten years.

   c. RAM: 8 Kilobytes

3. The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.

4. The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.

   a. Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.

   b. Accuracy: ±1 minute per month at 77° F (25° C).

c. Power Failure Backup: 24 hours at 32° to 100° F (0° to 38° C), 22 hours at 100° to 122° F (38° to 50° C).

5. The controller shall include Sylk Bus, a two wire, polarity insensitive bus that provides both 18 Vdc power and communications between a Sylk-enabled device and a Sylk-enabled controller.

6. The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.

7. The controller shall have an internal DC power supply to power external sensors.

a. Power Output: 20 VDC ±10% at 75 mA.

8. The controller shall have a visual indication (LED) of the status of the devise:

a. Controller operating normally.

b. Controller in process of download.

c. Controller in manual mode under control of software tool.

d. Controller lost its configuration.

e. No power to controller, low voltage, or controller damage.

f. Processor and/or controller are not operating.

9. The minimum controller Environmental ratings

a. Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).

b. Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).

c. Relative Humidity: 5% to 95% non-condensing.

10. The controller shall have the additional approval requirements, listings, and approvals:

a. UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.

b. CSA (LR95329-3) Listed

c. Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.

d. Meets Canadian standard C108.8 (radiated emissions).

e. Conforms to the following requirements per European Consortium standards:

EN 61000-6-1; 2001 (EU Immunity)

EN 61000-6-3; 2001 (EU Emissions)

11. The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).

12. The controller shall have sufficient on-board inputs and outputs to support the application.

    a. Analog outputs (AO) shall be capable of being configured to support 0-10 V, 2-10 V or 4-20 mA devices.

    b. Triac outputs shall be capable of switching 30 Volts at 500 mA.

    c. Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring. Input and Output wiring terminals shall be designated with color coded labels.

    d. Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).

13. The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara AX Framework™.

    a. The controller shall support 240 Network Variables with a byte count of 31 per variable.

    b. The controller shall support 960 separate data values.

14. The controller shall provide "continuous" automated loop tuning with an Adaptive Integral Algorithm Control Loop.

15. The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.

2.11 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating System:

1. The new system shall fully integrate with and be an extension of the existing GUI.

2.12 WEB BROWSER

A. The new system shall fully integrate with and be an extension of the existing web browser software.

2.13 SYSTEM CONFIGURATION TOOL

A. The new system shall fully integrate with and be an extension of the existing software.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the

screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.14 LonWorks NETWORK MANAGEMENT

A. The new system shall fully integrate with and be an extension of the existing software.

B. The Graphical User Interface software (GUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

C. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

D. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

E. These tools shall provide the ability to "learn" an existing LonWorks network, regardless of what network management tool(s) were used to install the existing network, so that existing LonWorks devices and newly added devices are part of a single network management database.

F. The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.15 LIBRARY

A. The new system shall fully integrate with and be an extension of the existing software

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

    1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.

    2. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.

    3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals

    4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

    5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.

    6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval

demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.

2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.

3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.

4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum.

Systems not employing the BACnet method of contention resolution shall not be acceptable.

5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.

6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.

7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.

8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.

9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.

10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an "On" state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.

11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.

3. For BACnet devices, provide the following objects at a minimum:
   a. Analog In
   b. Analog Out
   c. Analog Value
   d. Binary
   e. Binary In

           f. Binary Out

           g. Binary Value

           h. Multi-State In

           i. Multi-State Out

           j. Multi-State Value

           k. Schedule Export

           l. Calendar Export

           m. Trend Export

           n. Device

4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

5. For BACnet devices, provide the following support at a minimum:

           a. Segmentation

           b. Segmented Request

           c. Segmented Response

           d. Application Services

           e. Read Property

           f. Read Property Multiple

           g. Write Property

           h. Who-has

           i. I-have

           j. Who-is

           k. I-am

           l. Media Types

           m. Ethernet

           n. BACnet IP Annex J

           o. MSTP

           p. BACnet Broadcast Management Device (BBMD) function

           q. Routing

2.16 OTHER CONTROL SYSTEM HARDWARE

A. Current Switches: Solid state, split core, current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point shall be provided where specified. Current switches shall include an integral LED for indication of trip condition.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

           a. ACI

b. Honeywell as Installed by Taycon Building Technologies, Inc.

c. RIB, Inc.

d. Veris Industries

2. Sensing range 0.5 – 250 Amps.

3. Output 0.3 A @ 200 VAC/VDC / 0.15 A @ 300 VAC/VDC

4. Operating frequency 40 Hz -1 kHz.

5. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing

6. Approvals CE, UL.

B. Current Sensors: Solid state, split core linear current sensors shall be provided where specified.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

a. ACI

b. Honeywell as Installed by Taycon Building Technologies, Inc.

c. RIB, Inc.

d. Veris Industries

2. Linear output of 0-5 VDC, 0-10 VDC, or 4-20 mA.

3. Scale sensors so that average operating current is between 20-80% full scale.

4. Accuracy plus or minus 1.0% (5-100% full scale)

5. Operating frequency 50-600 Hz.

6. Operating Temperature 5-104 deg. F (-15 – 40 deg. C), Operating Humidity 0-95% non-condensing

7. Approvals CE, UL.

C. Differential Pressure Sensors

1. Manufacturers:

a. ACI

b. Honeywell as Installed by Taycon Building Technologies, Inc.

c. RIB, Inc.

d. Veris Industries

2. Sensor shall have four field selectable ranges: 0.1, 0.24, 0.5, 1.0 in w.c. for low pressure models, and 1.0, 2.5, 5, 10 for high pressure models.

3. Sensor shall provide zero calibration via pushbutton or digital input.

4. Sensor shall have field selectable outputs of 0-5 VDC, 0-10 VDC, and 4-20 mA

5. Where specified, sensor shall have and LCD display that displays measured value.

6. Sensor overpressure rating shall be 3 PSID proof, and 5 PSID burst.

7. Sensor accuracy shall be plus or minus 1% FS selected range.

D. Low Leakage Automatic Control Dampers. Provide all automatic control dampers not specified to be integral with other equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   a. Greenheck
   b. Honeywell as Provided by Taycon Building Technologies, Inc.
   c. Johnson Controls
   d. Ruskin

2. Frames shall be 5 inches wide and of no less than 16-gauge galvanized steel. Inter-blade linkage shall be within the frame and out of the air stream.

3. Blades shall not be over 8 inches wide or less than 16-gauge galvanized steel triple V type for rigidity.

4. Bearings shall be acetyl, oilite, nylon or ball-bearing with ½ inch diameter plated steel shafts.

5. Dampers shall be suitable for temperature ranges of -40 to 180F.

6. All proportional control dampers shall be opposed or parallel blade type as hereinafter specified and all two-position dampers shall be parallel blade types.

7. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6". Dampers with dimensions of 24 inches and less shall be rated for 3,000 fpm velocity and shall withstand a maximum system pressure of 5.0 in. w.c. Dampers with dimensions of 36 inches and less shall be rated for 2,500 fpm velocity and shall withstand a maximum system pressure of 4.0 in. w.c. Dampers with dimensions of 48 inches and less shall be rated for 2,000 fpm velocity and shall withstand a maximum system pressure of 2.5 in. w.c.

8. Side seals shall be stainless steel of the tight-seal spring type.

9. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage data for all low leakage control dampers with the temperature control submittal.

10. Maximum leakage for low leakage dampers in excess of sixteen inches square shall be 8 CFM per square foot at static pressure of 1 inch of WC.

11. Low leakage damper blade edges shall be fitted with replaceable, snap-on, inflatable seals to limit damper leakage.

12. Testing and ratings shall be in accordance with AMCA Standard 500.

13. Damper blade width shall be no greater than 8 inches, and dampers over 48 inches wide by 74 inches high shall be sectionalized. Testing and ratings to be in accordance with AMCA Standard 500.

E. Variable Frequency Drives.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

   a. ABB

   b. Honeywell as provided by Taycon Building Technologies, Inc.

   c. Siemens Building Technologies

   d. Culter-Hammer

2. Variable frequency drives shall be UL listed and sized for the power and loads applied.

3. Drives shall include built-in radio frequency interference (RFI) filters and be constructed to operate in equipment rooms and shall not be susceptible to electromagnetic disturbances typically encountered in such environments. Similarly, the drives must not excessively disturb the environment within which it is used.

4. All VFDs over 3 horsepower shall be provided with an AC choke.

5. VFDs shall be installed in strict conformance to the manufacturer's installation instructions, and shall be rated to operate over a temperature range of 14 to 104 F.

6. VFD automatic operation shall be suitable for an analog input signal compatible with the digital controller output.

7. Each VFD shall be fan cooled and have an integral keypad and alphanumeric display unit for user interface. The display shall indicate VFD status (RUN motor rotation, READY, STOP, ALARM, and FAULT), and shall indicate the VFD current control source (DDC input signal, keypad, or field bus control). In addition to the alphanumeric display, the display unit shall have three pilot lights to annunciate when the power is on (green), when the drive is running (green, blinks when stopping and ramping down), and when the

drive was shut down due to a detected fault (red, fault condition presented on the alphanumeric display).

8. Three types of faults shall be monitored, "FAULT" shall shut the motor down, "FAULT Auto-reset" shall shut the motor down and try to restart it for a programmable number of tries, and "FAULT Trip" shall shut the motor down after a FAULT Auto-reset fails to restart the motor. Coded faults shall be automatically displayed for the following faults:

> Over current
> Over voltage
> Earth ground
> Emergency stop
> System (component failure)
> Under voltage
> Phase missing
> Heat sink under temperature
> Heat sink over temperature
> Motor stalled
> Motor over temperature
> Motor under load
> Cooling fan failure
> Inverter bridge over temperature
> Analog input control under current
> Keypad failure
> Other product unique monitored conditions

9. In addition to annunciating faults, at the time of fault occurrence the VFD shall capture and make available to the user certain system data for subsequent analysis during fault trouble shooting, including duration of operation (days, hours, minutes, seconds),output frequency, motor current, motor voltage, motor power, motor torque, DC voltage, unit temperature, run status, rotation direction, and any warnings. The last 30 fault occurrences shall be retained as well as the fault data listed in the previous sentence of each fault. New faults beyond 30 shall overwrite the oldest faults.

10. The display unit keypad shall allow setting operational parameters including minimum and maximum frequency, and acceleration and deceleration times. The display shall offer user monitoring of

frequency, unit temperature, motor speed, current, torque, power, voltage, and temperature.

F. **Actuators, General.** All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Valves shall be provided with actuators suitable for floating or analog signal control as required to match the controller output. Actuators shall be power failure return type where valves or dampers are required to fail to a safe position and where specified.

G. Non-Spring Return Low Torque Direct Coupled 35 & 70 lb-in Actuators. Actuators shall be 35 or 70 lb-in. with strokes adjustable for 45, 60, or 90 degree rotation applications and designed for operation between 20 and 125 F.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

      a. Honeywell as Installed by Taycon Building Technologies, Inc.

      b. Johnson Controls

      c. Siemens Building Technologies

   2. Each actuator shall also have a minimum position adjustable rotation of 0 to 30 degrees.

   3. Actuators shall be for floating or two position (ML 6161 or ML6174) control, or for 4-20 mA or 2-10Vdc (ML7161 or ML7174) input signals.

   4. Analog control actuators shall have a cover mounted direct/reverse acting switch.

   5. Actuator motor shall be magnetically coupled or shall have limit switch stops to disengage power at the ends of the stroke.

   6. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

   7. Actuators shall have NEMA 1 environmental protection rating and be 24 volt and UL listed with UL94-5V plenum requirement compliance.

   8. Minimum design life of actuators shall be for 1,500,000 repositions and 35 lb-in. models shall be designed for 50,000 open-close cycles and 70 lb-in. models shall be designed for 40,000 open-close cycles.

   9. Actuator options shall include 1) Auxiliary feedback potentiometers, 2) open-closed indicator switches, 3) actuator timings of 90 seconds, 3 minutes, or 7 minutes, one or two auxiliary switches, and 4) torque of 35 or 70 lb-in.

H. Non-Spring Return High Torque 177 and 300 lb-in Actuators. Actuators shall be UL listed 24 Vac in NEMA 2 enclosures designed for operation between -5 and 140 F.

    1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

        a. Honeywell as Installed by Taycon Building Technologies, Inc.

        b. Johnson Controls

        c. Siemens Building Technologies

    2. Rotation direction shall be switch selectable.

    3. Minimum design life of actuators shall be for 1,500,000 repositions and for 60,000 open-close cycles.

    4. Actuators shall be suitable for the controller output signals encountered, floating or analog, and shall have full cycle timing of 95 seconds.

    5. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

        • Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees.

I. Spring Return Direct Coupled Actuators. Actuators shall have torque ratings of 44lb-in., 88 lb-in., or 175 lb-in. Actuators shall be modulating 90 seconds nominal timing or two-position 45 seconds nominal timing types with strokes for 90 degree rotation applications and designed for operation between -40 and 140 F.

    1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

        a. Honeywell as Installed by Taycon Building Technologies, Inc.

        b. Johnson Controls

        c. Siemens Building Technologies

    2. Each torque rating group shall have optionally selected control types, floating control, 2-position 24 Vac, 2-position line voltage, or analog input which is switch selectable as 0-10Vdc, 10-0 Vdc, 2-10 Vdc, or 10-2 Vdc.

    3. Actuator spring return direction (open or closed) shall be easily reversed in the field, and actuators shall spring return in no greater than 20 seconds.

    4. Actuators shall be direct connected (no linkages), and shall have integral position indication.

5. Actuators shall have NEMA 2 environmental protection rating, and UL approved and plenum rated per UL873.

6. Minimum design life of modulating actuators shall be for 1,500,000 repositions and 60,000 spring returns, except 2-position actuators shall be for 50,000 spring returns.

7. Each actuator shall be provided with a manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action.

8. Upon power restoration after gear lock, normal operation shall automatically recur.

9. Actuators control shall be compatible with SPST control switch and with torque ratings of 30 lb-in.

10. Actuator timing shall be 25 seconds maximum in powered instances and shall spring-return in 15 seconds.

11. Actuators shall be UL listed with UL873 plenum rating with die-cast aluminum housing with integral junction box and conduit knockouts, and designed to operate reliably in smoke control systems requiring UL555S ratings up to 350F.

12. The actuator shall be designed to operate for 30 minutes during a one-time excursion to 350F.

13. Actuator shall require no special cycling during long-term holding, and shall "hold" with no audible noise at a power consumption of approximately half of the driving power.

14. Actuators shall be 24 volt or 120 volt with models for clockwise (add a B suffix) and counter-clockwise (add an A suffix) spring return.

J. Temperature Control Panels: Furnish temperature control panels of 12 gauge steel with oil/duct gasket locking doors for mounting all devices. Control panels shall meet all requirements of Title 24, California Administrative Code. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

PART 3 EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office

shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

C. Drawings of the TCS and FMCS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.

E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2   WIRING

A. All electrical control wiring and power wiring to the control panels, NAC, computers and network components shall be the responsibility of the this contractor.

B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.

C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All FMCS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where FMCS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after

receipt of notice) repaired or replaced by this contractor at no expense to the Owner

3.4 WARRANTY ACCESS

A. The Owner shall grant to this contractor, reasonable access to the TCS and FMCS during the warranty period.

B. The owner shall allow the contractor to access the TCS and FMCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.

B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: Satisfactory completion is when this contractor and the Division 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the TCS and FMCS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. This contractor shall provide 40 hours of instruction to the owner's designated personnel on the operation of the TCS and FMCS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:

1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.

2. First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

3. Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

PART 4 SEQUENCES OF OPERATION

4.1   SUMMARY

A. This contractor shall coordinate control functions, such as scheduling and supervisory-level global control, points list, and control sequences needed for this installation. Contractor shall provide written documentation to archive the system operation as accepted by the owner.

PART 5 GRAPHICAL REPRESENTATION POINT LISTS

5.1 SUMMARY

A. The points in the following table shall be accessible from the Graphical User Interface (GUI) and/or the Web browser interface (WBI). The supplier of the IDC and IBC devices shall ensure that the points listed in this table are accessible on their respective networks, by the Network Area Controller (NAC).

B. The graphics shall provide detailed 2-dimensional building site, 2-dimensional floor plans; and 3-dimentional equipment illustrations with fan, pump, damper, and valve animation for system operation. Each graphic shall be provided with a tabular "hot button" navigational structure enabling a "one-mouse click" access to other building systems and the return, without the use of the browser "back button".

C. The graphics shall provide a real-time continuous display of critical points; Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, and KW visible within the HTML frame on all graphic screens.

5.2   GRAPHIC DESCRIPTION

A. Home Page:

1. The graphic shall provide a geographical overview of the multiple-site enterprise or campus buildings. Each building image shall be a "hot button" to access the building floor plans. The image "hot button" is indicated by a "mouse over" function highlighting the building and changing curser icon, enabling a "one-mouse click" access the building floor plans.

B. Floor Plans:

1. The graphic shall provide an accurate dimensional layout of the building floor(s); including all rooms, room numbers, walls, elevators, doors, entrances, hallways, and stairwells. Room numbering and naming conventions shall be provided by the COR.

2. All space sensors shall be placed on the Floor Plan graphic accurately depicting their location. Each sensor image shall be a "hot button" to access the associated equipment. The image "hot button" is indicated by a "mouse over" function changing curser icon, enabling a "one-mouse click" access to the equipment. The sensors shall be tagged with a real-time continuous display of their value.

3. Building floor layout with large area or high density of sensors. The graphic shall provide an accurate dimensional layout of the building floor(s) divided into logical sections or areas. Each section or area shall be a "hot button" to access an expanded view. The section or area "hot button" is indicated by a "mouse over" function highlighting the section or area and changing curser icon, enabling a "one-mouse click" access to the expanded view. Expanded view; all space sensors shall be placed on the graphic accurately

depicting their location. Each sensor image shall be a "hot button" to access the associated equipment. The image "hot button" is indicated by a "mouse over" function changing curser icon, enabling a "one-mouse click" access to the equipment. The sensors shall be tagged with a real-time continuous display of their value.

C. Mechanical Systems:

1. The graphic shall provide an accurate 3-dimensional representation of the system being controlled; including all sensors, dampers, flow directions, safety devices, actuators, and limit devices with fan and damper animation for real-time system operation.

2. All data point components shall be placed on the system graphic accurately depicting their location. Each component image shall be a "hot button" to access their respective schedule, set-points, and trend logs. The image "hot button" is indicated by a "mouse over" function changing curser icon, enabling a "one-mouse click" access to the parameters. All analog and digital components shall be tagged with a real-time continuous display of their value.

<div align="center">---END OF SECTION---</div>